SPACE LIFE SCIENCES SYMPOSIUM (A1)
Radiation Fields, Effects and Risks in Human Space Missions (4)

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LUNAR RADIATION ENVIRONMENT: FINAL COMPARISONS BETWEEN MODELS AND THE CHANDRAYAAN-1 RADOM EXPERIMENT DATA

Abstract

Lunar radiation environment models have been obtained in the framework of the RADOM investigation that is onboard the CHANDRAYAAN-1 mission by the Indian Space Agency ISRO. The instrument is a miniature (98 grams, 100 mW) 256 channels spectrometer of the deposited energy (dose) in a single 2 cm2 0.3 mm thick silicon detector, managed by microcontrollers. RADOM instrument was switched on about 2 hours after the launch of the Chandrayaan-1 satellite on 22nd October 2008. When on 12th November 2008 the satellite entered a 100 km circular orbit around the Moon the GCR doses fall down because of the Moon surface shielding to about 8.8 μGy/h and remained stable around this value. In May 2009 the spacecraft was inserted on a 200 km circular orbit, and stayed on this orbit until failure. Models for the Moon radiation environment have been compared with the data coming from the RADOM experiment: models of Galactic Cosmic Rays (GCR) and Solar Particle Events (SPE) primary particles impinging on the lunar surface, transported through the subsurface layers, with backscattering taken into account, and interacting with some described targets. The lunar surface and subsurface has been modeled as regolith and bedrock, with structure and composition taken from the results of the instruments of the Luna, Ranger, Lunar Surveyor and Apollo missions, as well as from ground-based measurements. In order to perform the comparison with the RADOM spacecraft data, the models have been set to according to the actual mission time frame (both punctual and averaged data), and to the actual environmental shielding inside the spacecraft. If for the comparison the above model is used, rescaled for CHANDRAYAAN-1 orbital conditions and timeframe, with a shielding pattern of 0.45 g/cm2 on the 2π solid angle before the detector and more shielding on the other 2π solid angle at the back side of the detector, these comparisons are giving satisfactory results: the agreement is at the 3-4% level closer to the surface of the Moon, at 8% level further away. The values for the results for the models are always higher than those from the RADOM data, and we might have found a cause for this systematic discrepancy: because of the accommodation of the RADOM instrument onboard the CHANDRAYAAN-1 spacecraft, the value for FOV solid angle before the detector is not exactly 2π, but a slightly lower value. This could explain the discrepancy observed between models and data.